Missouri Department of Natural Resources

Biological Assessment and Dissolved Oxygen Study

West Fork Medicine Creek
Mercer and Grundy Counties, Missouri

Fall 2007 - Spring 2008

Prepared for:
Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

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Appendix B Macroinvertebrate Bench Sheet Report for West Fork Medicine Creek, Fall 2006 and Spring 2007

Appendix C USGS National Water Information System, Web Interface for Medicine Creek, near Laredo, Missouri, Gage height and discharge information, January 1, 2008–May 1, 2008, Sample Dates March 26 and 27, 2008

1.0 Introduction

The headwaters of West Fork Medicine Creek originate in Wayne County, Iowa. The stream then enters north-central Missouri in Mercer County and continues through Grundy County to it's confluence with Medicine Creek, approximately two miles south of Galt, Missouri (Figure 2). West Fork Medicine Creek is located in the Central Plains/Grand/Chariton Ecological Drainage Unit (**EDU**) (Figure 1).

West Fork Medicine Creek is assigned Water Body Identification Number 623 (**WBIN**). The WBIN 623 reach is approximately 40 miles long and is a class P stream with designated beneficial uses for livestock and wildlife watering (**LWW**), protection of warm water aquatic life and human health-fish consumption (**AQL**), and whole body contact (**WBC**) category B (MDNR 2005c). Class P streams maintain permanent flow even during drought periods. The WBC category B applies to waters designated for whole body contact recreation not contained within category A, which states: "those water segments that have been established by the property owner as public swimming areas allowing full and free access by the public for swimming purposes and waters with existing whole body contact recreational use(s). Examples of this category include, but are not limited to, public swimming beaches and property where whole-body contact recreational activity is open to and accessible by the public through law or written permission of the landowner" (MDNR 2005c).

1.1 Justification

West Fork Medicine Creek is on the Missouri Department of Natural Resources (**MDNR**) 2004-2006 impaired waters list under section 303(d) of the Federal Clean Water Act. The stream is listed for unknown pollutants with an unknown source (MDNR 2009).

Two biological studies have been conducted on West Fork Medicine Creek prior to this assessment. A study was conducted from 1996 through 2000 by an independent consulting firm after a major manure spill, at the request of a consent decree. In 2003-2004, MDNR Environmental Services Program (**ESP**) conducted a biological assessment of the upstream 14 miles. The lower 26 miles were assessed by ESP in 2004-2005. The three years of study by ESP were combined into a comprehensive report in 2005 (MDNR 2005a).

As a result of these previous studies, the Macroinvertebrate Stream Condition Index (**MSCI**; MDNR 2003d) scores were calculated and biological support categories were assigned to each test station and compared to reference stations. The criterion for further study, or continued 303(d) listing of stream segments, is a comparison of full to partial or non-supporting MSCI scores between test and reference streams. The actual MSCI ratio for reference streams in the Central Plains/Grand/Chariton EDU is 79% supporting - 21% not supporting. According to current procedure, the test stream in that EDU must not be different from the EDU ratio or additional studies will be required. The ratio for the 2003-2005 study was 89% supporting - 11% not supporting, well above the EDU ratio. However, when 2003-2005 data were combined with the 1996-2000 study the biological

support ratio decreased to 73% supporting - 27% not supporting, less than the EDU ratio. Given those results, an additional biological assessment with a stressor study was conducted on West Fork Medicine Creek, Mercer and Grundy counties in 2007 and 2008.

A study proposal was written for additional bioassessment and a stressor study on West Fork Medicine Creek, Mercer and Grundy counties on July 27, 2007 (Appendix A). This study includes those aspects called for in the study proposal.

The study was conducted at the request of the Missouri Department of Natural Resources (**MDNR**), Water Protection Program (**WPP**), Water Pollution Control Branch (**WPCB**). The 2007-2008 biological assessment and stressor study of West Fork Medicine Creek, Mercer and Grundy counties was conducted by the Field Services Division (**FSD**), Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**) and Chemical Analysis Section (**CAS**).

1.2 Objectives

1) Assess the macroinvertebrate community integrity and water quality of West Fork Medicine Creek.

2) Identify the diurnal dissolved oxygen concentrations in West Fork Medicine Creek.

1.3 Null Hypotheses

1) Macroinvertebrate communities are similar between reaches of West Fork Medicine Creek from upstream to downstream and to biological criteria index scores.

2) Water quality is similar from upstream to downstream and within acceptable water quality standards (**WQS**; MDNR 2005c).

3) Daily dissolved oxygen concentrations will be within WQS.

2.0 Methods

Kenneth B. Lister (ESP), Brandy Bergthold (ESP), and staff of the WQMS conducted this study. Methods are outlined in this section. The study area and station descriptions are described. Study timing is outlined. Ecological Drainage Units and land uses are defined and identified. Biological assessment procedures are discussed, which include macroinvertebrate community and physicochemical water collection and analyses.

2.1 Study Area and Station Descriptions

The study area included West Fork Medicine Creek (**WFMC**) from the Iowa border to Galt, Missouri (Table 1; Figure 1). The total length of the study area was approximately 40 miles. Six stations were allocated for this project (Table 1; Figure 2). Stations were located approximately five miles apart. The distance between upstream to downstream

stations is approximately 30 miles. Stations used in this project were selected from those used in the two previous MDNR studies, 2003-2004 and 2004-2005 (MDNR 2005a; Table 1 in Appendix A).

Table 1
Location and Descriptive Information for West Fork Medicine Creek (WFMC) Stations in Mercer and Grundy Counties, 2007-2008

Stream-Station Number	Section, Township, Range; and Coordinates	Description	County
WFMC 6	SW ¼ sec. 05, T. 65 N., R. 22 W. UTM E 465796 UTM N 4478763	Upstream from US Hwy 136 bridge	Mercer
WFMC 5	SE ¼ sec. 19, T. 65 N., R. 22 W. UTM E 465274 UTM N 4473860	App. ½ mile downstream County Road 142; VanDyke Conservation Area	Mercer
WFMC 4	NE ¼ sec. 20, T. 64 N., R. 22 W. UTM E 466610 UTM N 4465473	Downstream from Intrepid Street bridge	Mercer
WFMC 3	SW ¼ sec. 04, T. 63 N., R. 22 W. UTM E 467556 UTM N 4459373	Upstream from Jukebox Street bridge	Mercer
WFMC 2	NW ¼ sec. 04, T. 62 N., R. 22 W. UTM E 467791 UTM N 4450785	Downstream from 90th Street bridge	Grundy
WFMC 1	N ½ sec. 33, T. 62 N., R. 22 W. UTM E 467693 UTM N 4442347	Upstream from MO Hwy 6 bridge	Grundy

2.2 Study Timing

Samples were collected and field analyses were conducted in fall 2007, summer 2007, and spring 2008. Fall biological assessment samples were collected on September 18, 2007 at stations 6, 5, 4a, and 4b (duplicate samples). Stations 3, 2, and 1 were sampled on September 19, 2007. A discrete dissolved oxygen study was conducted at all stations in the summer on August 1 and 2, 2007. Spring biological assessment samples were collected on March 26, 2008 at stations 5, 3, and 2. Stations 6 and 4 were sampled on March 27, 2008. Station 1 was not sampled in the spring due to high stream flow.

2.2.1 Ecological Drainage Unit

West Fork Medicine Creek is located within the Central Plains/Grand Chariton EDU (Figure 1). Ecological Drainage Units are delineated drainages that are described by their physiographic and major riverine components. Similar size streams within an EDU are expected to contain similar aquatic communities and stream habitat conditions. Comparisons of biological and physicochemical results between test streams and similar size reference streams within the same EDU should then be appropriate.

2.2.2 Land Use Description

Land cover was compared between WFMC stations and the Central Plains/Grand/Chariton EDU using a 14-digit Hydrological Unit scale (**HUC-14**; Table 2). Percent land cover data were derived from Thematic Mapper satellite data collected between 2000 and 2004 and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**).

Land cover was generally similar between WFMC stations and the Central Plains/Grand/Chariton EDU (Table 2). All stations had a relatively high percentage of grassland followed by relatively even urban, crop, forest, and wetland land use. Cropland use differed slightly between upstream and downstream stations by eight percent, and by 14 percent with the EDU. Grassland differed between test stations by eight percent, and by 16 percent with the EDU. The upstream HUC had less cropland and more grassland than the downstream. Overall, land use was generally similar between the stations and the EDU. Comparisons of the stream communities within the EDU should be appropriate.

Table 2
Percent Land Cover in West Fork Medicine Creek (WFMC) Stations in the Central Plains/Grand/Chariton EDU

Stations	HUC-14	Urban	Crops	Grass	Forest	Wet	Open water
WFMC 6, 5	10280103040001	2	14	61	16	4	0
WFMC 4,3,2,1	10280103040003	2	22	53	16	4	0
Central Plains/ Grand/Chariton EDU	N/A	2	28	45	18	--	--

HUC-14 = 14-digit Hydrologic Unit Code; EDU = Ecological Drainage Unit

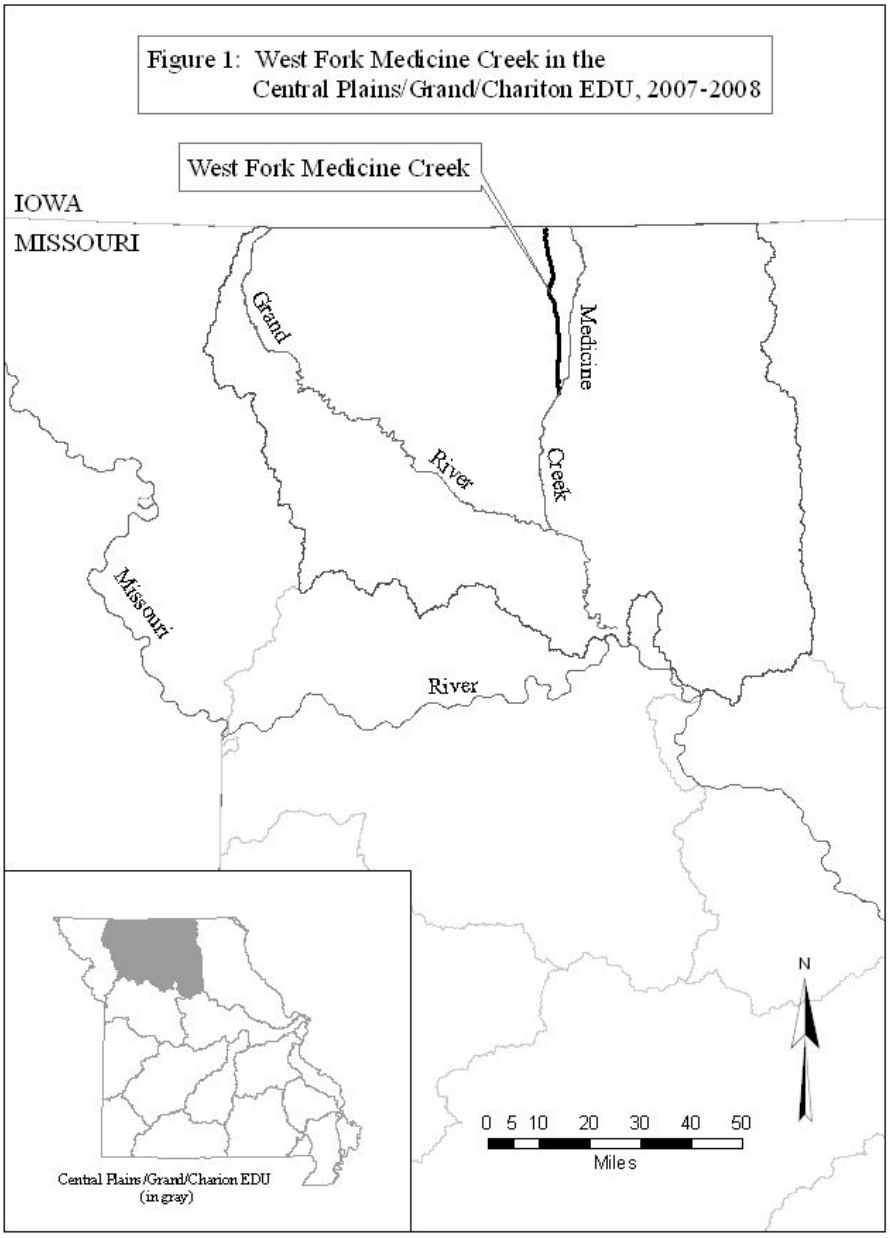


Figure 1: West Fork Medicine Creek in the Central Plains/Grand/Chariton EDU, 2007-2008
West Fork Medicine Creek
IOWA
MISSOURI
Grand
River
Medicine
Creek
Missouri
River
N
0 5 10 20 30 40 50
Miles
Central Plains/Grand/Charion EDU
(in gray)

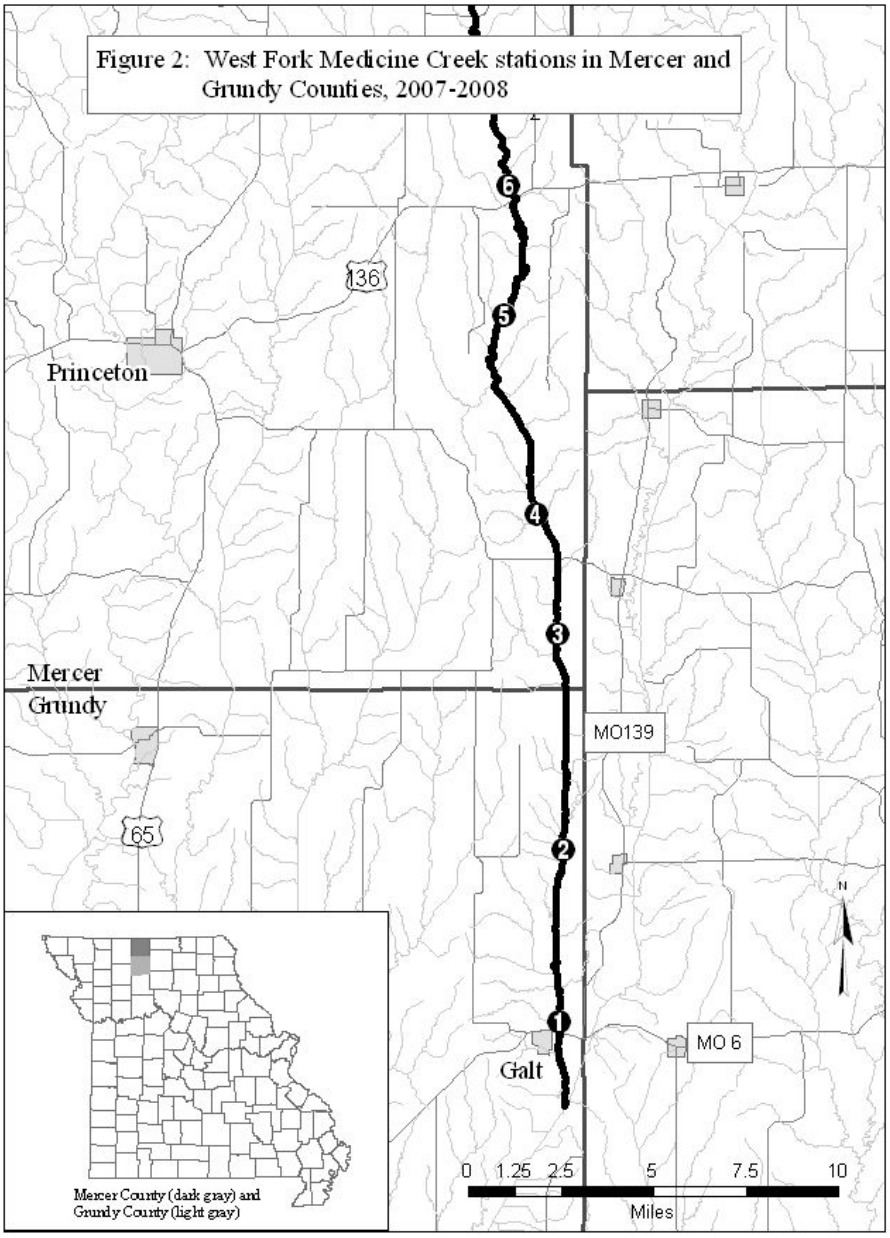


Figure 2: West Fork Medicine Creek stations in Mercer and Grundy Counties, 2007-2008
6
5
4
3
2
1
136
Princeton
Mercer
Grundy
MO139
65
MO 6
Galt
N
0 1.25 2.5 5 7.5 10
Miles
Mercer County (dark gray) and Grundy County (light gray)

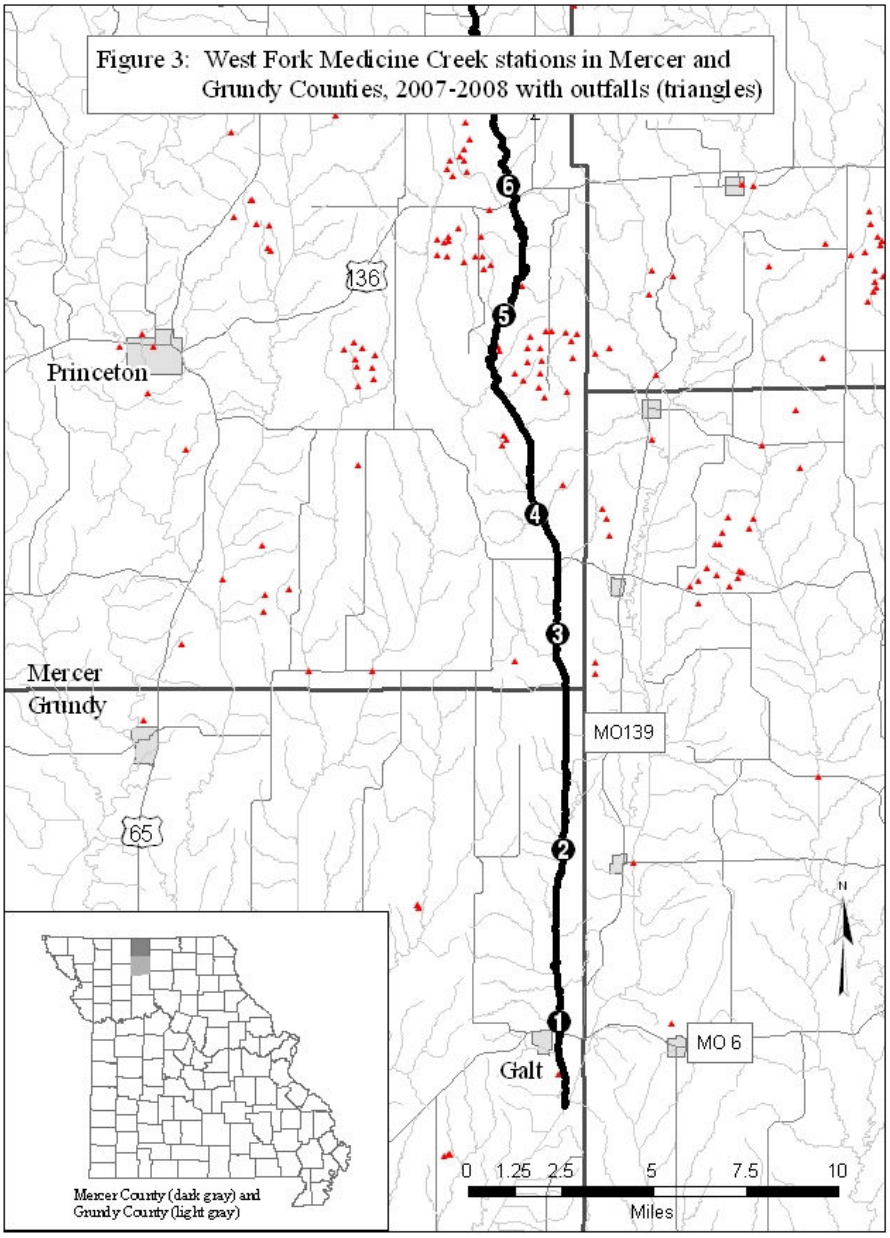


Figure 3: West Fork Medicine Creek stations in Mercer and Grundy Counties, 2007-2008 with outfalls (triangles)
136
Princeton
Mercer
Grundy
65
MO139
MO 6
Galt
6
5
4
3
2
1
N
0 1.25 2.5 5 7.5 10
Miles
Mercer County (dark gray) and Grundy County (light gray)

2.3 Biological Assessment

Sampling was conducted as described in the MDNR Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP,** MDNR 2003d). The biological assessment consisted of macroinvertebrate community and physicochemical water collection and analyses.

2.3.1 Macroinvertebrate Sampling and Analyses

Macroinvertebrates were sampled from multiple habitats as described in the SMSBPP (MDNR 2003d). West Fork Medicine Creek is considered to be a glide/pool dominant stream. As such, non-flowing water over depositional substrate (**NF**), large woody debris (**SG**), and rootmat (**RM**) habitats were sampled. Macroinvertebrates were subsampled in the WQMS lab according to the SMSBPP and identified to specific taxonomic levels in order to standardize calculation of the metrics (MDNR 2003d; MDNR 2005b).

Macroinvertebrate community data were analyzed using three strategies. Macroinvertebrate Stream Condition Index (**MSCI**) scores, individual biological criteria metrics, and dominant macroinvertebrate families (**DMF**) were examined and compared from upstream to downstream.

A Macroinvertebrate Stream Condition Index score is a qualitative or rank measurement of a stream's aquatic biological integrity (Rabeni et al. 1997). The MSCI was further refined for reference streams within each EDU in Biological Criteria for Perennial/Wadeable Streams (**BIOREF,** MDNR 2003d).

A station's MSCI score is a compilation of rank scores that were assigned to individual biological criteria metrics as a measure of biological integrity (as seen in Tables 3 & 4). Four primary biological criteria metrics were used to calculate the MSCI per station: 1) Taxa Richness (**TR**); 2) Ephemeroptera/Plecoptera/Trichoptera Taxa (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**). Metric scores were compared to the BIOREF scoring range (MSCI Scoring Table, in light gray) and rank scores (5, 3, 1) were assigned to each metric. These rank scores were compiled from all metrics in each station and the MSCI score was completed. The MSCI scores are interpreted as follows: 20-16 = full biological support; 14-10 = partial biological support; and 8-4 = non-support of the beneficial use AQL. MSCI scores were compared between stations and grouped by season.

Secondly, the individual biological criteria metrics for each station were compared to the BIOREF scoring range to identify the level of integrity for each individual metric. Variations in the metrics may help identify how a community is affected and the potential source of impairment.

The third biological analysis was an evaluation of the "dominant macroinvertebrate families" (**DMF**) per station. The seven most abundant DMF for each station are listed as a percentage of the total number of individuals in the sample. Dominance by certain

families may also help identify the type and source of impairment. A complete taxa list reported by season and station is attached as Appendix B.

2.3.2 Physicochemical Water Sampling and Analyses

Water was handled according to the appropriate MDNR, ESP Standard Operating Procedures (**SOP**) for sampling and analyzing physicochemical water samples. Results for physicochemical water parameters were examined by season and station.

Fall 2007 and spring 2008 physicochemical water parameters consisted of field measurements and grab samples that were returned to the ESP environmental laboratory. Temperature, pH, conductivity, dissolved oxygen, and discharge were measured *in situ*. Water samples were collected in accordance with the SOP MDNR-ESP-001 Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2008). The ESP, Chemical Analysis Section in Jefferson City, Missouri conducted analyses for nitrogen ammonia (**NH_3-N**), nitrate+nitrite as nitrogen (**NO_3+NO_2-N**), total nitrogen (**TN**), chloride, and total phosphorus (**TP**). Turbidity was measured and recorded in the WQMS biology laboratory. All samples returned to ESP were kept on ice.

Physicochemical water parameters were compared between stations from upstream to downstream, as well as within acceptable limits of the Missouri Water Quality Standards (**WQS**, MDNR 2005c). Interpretation of acceptable limits in the WQS may be dependent on a stream's classification and beneficial-use designation (MDNR 2005c). West Fork Medicine Creek is a class P stream with designated beneficial uses for LWW, AQL, and WBC category B. Furthermore, acceptable limits for some parameters may be dependent on the rate of exposure. These exposure or toxicity limits are based on the lethality of a toxicant given long (chronic toxicity, **c**) or short-term exposure (acute toxicity, **a**).

2.3.3 Discharge

Stream discharge was measured and calculated for each station. Velocity and depth measurements were recorded at each station in accordance with SOP MDNR-WQMS-113 Flow Measurement in Open Channels (MDNR 2003b). Velocity was measured using a Marsh-McBirney Flowmate™ flow meter.

2.4 Diurnal Dissolved Oxygen Study

In order to identify diurnal dissolved oxygen concentrations at all WFMC stations, a discrete study was conducted generally using recommendations in the Wasteload Allocation/Special Stream Studies Project Procedure (MDNR 2003e). Dissolved oxygen measurements were measured using a YSI hand-held field meter, either directly from the stream or from water samples collected in a 2.5 gallon bucket (MDNR 2002). Temperature was measured in accordance with SOP MDNR-FSS-101 (MDNR 2003a). Higher stream temperatures during summer months potentially relate to lower dissolved oxygen concentrations.

The discrete dissolved oxygen study was conducted in two days. The dissolved oxygen measurements were collected sequentially from upstream to downstream. Each station was sampled two times during the afternoon of August 1, 2008 and another two times during the morning of August 2, 2008. This allowed for development of four discrete time periods spanning the hours of 0750 through 1645 to observe potential fluctuations of dissolved oxygen concentrations. Each time period was approximately 1.5 hours long, with ranges from 0750-0935, 1020-1215, 1225-1410, and 1520-1645. Data were assembled to illustrate concentrations by station over time and by time period.

3.0 Results

Results include the biological assessment and examination of the diurnal dissolved oxygen concentrations.

3.1 Biological Assessment

The biological assessment includes the examination of the macroinvertebrate community and the water quality in WFMC.

3.1.1 Macroinvertebrate Community Analyses

Macroinvertebrate community analyses include comparison of MSCI scores, individual biological metrics, and examination of dominant macroinvertebrate families. Analyses are arranged by fall and spring. A complete list of taxa sampled during both seasons is found in Appendix B.

In the fall, MSCI scores show that all six stations were fully supportive of the beneficial use AQL (Table 3). Four of the stations had MSCI scores of 16, while two had 18 and one 20. Upstream stations 6 through 4 had scores of 16, while downstream stations scored slightly higher.

Individual metrics in the fall scores identified stations with less than optimum BIOREF scores (Table 3). Station 3 had a TR that was less than the optimum. EPTT at 5 was below optimum and about half that of the highest number. The BI was slightly higher than the optimum in the upstream stations 6, 5, and 4 and much lower in the downstream stations 3, 2, and 1.

3.1.1.1 Macroinvertebrate Community QC

The duplicate MSCI score at station 4b scored 18, while station 4a scored 16. The difference between these scores was a BI score at 4b that was higher than 4a based on a very slight difference in BI values (0.2). The margin was too narrow to suggest that the samples were not comparable.

Table 3
Biological Criteria (BIOREF) Metric Scores, Biological Support Category, and Macroinvertebrate Stream Condition Index (MSCI) Scores for West Fork Medicine Creek (WFMC), Mercer and Grundy Counties, Fall 2007

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	MSCI	Support
WFMC 6	0703257	60	13	**7.2**	**2.59**	16	F
WFMC 5	0703258	65	**8**	**7.2**	2.72	16	F
WFMC 4a	0703259	62	11	**7.2**	**2.57**	16	F
WFMC 4b	0703260	60	10	7.0	**2.31**	18	F
WFMC 3	0703261	**46**	11	6.4	**2.59**	16	F
WFMC 2	0703262	67	16	6.3	2.91	20	F
WFMC 1	0703263	55	14	6.6	**2.64**	18	F
BIOREF Score=5	--	>53	>9	<7.2	>2.69	20-16	**F**ull
BIOREF Score=3	--	53-27	9-5	7.2-8.6	2.69-1.35	14-10	**P**artial
BIOREF Score=1	--	<27	<5	>8.6	<1.35	8-4	**N**on

MSCI Scoring Table (in light gray) developed from BIOREF streams (n=18); TR=Taxa Richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index

MSCI scores in the spring were much lower than the fall scores (Table 4). Four of the five stations sampled were partially supporting the designated beneficial use AQL. Stations 6 through 3 were partially supporting with three scores of 12 and one of 14. Station 2 was fully supporting with a score of 16. WFMC station 1 was not sampled in the spring due to high flow.

Most individual metrics in the spring scores were less than optimum at all stations sampled (Table 4). Station 5 SDI indicated higher diversity with the optimum range. Higher EPTT and lower BI increased the MSCI score to the full support level at station 2. All other metrics were outside the optimum range yet within the mid-range.

Table 4
Biological Criteria (BIOREF) Metric Scores, Biological Support Category, and Macroinvertebrate Stream Condition Index (MSCI) Scores for West Fork Medicine Creek, Mercer and Grundy Counties, Spring 2008

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	MSCI	Support
WFMC 6	0804025	36	6	7.9	2.19	12	P
WFMC 5	0804021	47	6	7.7	2.64	14	P
WFMC 4	0804024	37	5	7.6	1.87	12	P
WFMC 3	0804023	48	7	7.5	2.18	12	P
WFMC 2	0804022	41	9	7.2	2.17	16	F
WFMC 1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BIOREF Score=5	--	>51	>8	<7.3	>2.53	20-16	**F**ull
BIOREF Score=3	--	51-25	8-4	7.3-8.7	2.53-1.27	14-10	**P**artial
BIOREF Score=1	--	<25	<4	>8.7	<1.27	8-4	**N**on

MSCI Scoring Table (in light gray) developed from BIOREF streams (n= 23); TR=Taxa Richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index; n/a=not sampled due to high water

The dominant macroinvertebrate families are examined for the fall in Table 5. Chironomidae and Caenid mayflies were the most dominant families at all stations. Chironomids were usually most prevalent ranging from a high of 61 percent to a low of 24.5 percent. Caenids ranged from 17 to 46 percent. Leptocerid caddisflies and ephemerid mayflies were among the dominant taxa in the lower stations with less than 10 percent. Baetid mayflies were among the dominant taxa at all stations, ranging from approximately 1 to 10 percent of the total number of individuals in the sample.

The dominant macroinvertebrate families were examined for spring in Table 6. Chironomidae and Caenidae were the most abundant of all the families at all stations in the spring. Chironomids decreased from 75 percent upstream to 32 percent downstream. Caenids increased from 12 percent to around 50 percent of the sample by station 4 to be the most dominant taxa. Tubificid worms were among the dominant families at stations 6, 5, and 2 while enchytraeid worms were on the dominant taxa list in the spring at all stations with up to 3 percent of the total. Baetid mayflies were among the dominant families in station 2 with 1.2 percent

Table 5
Dominant Macroinvertebrate Families (DMF) as a Percentage of the Total Number of Individuals per Station, West Fork Medicine Creek, Fall 2007

West Fork Medicine Creek Station	**6**	**5**	**4a**	**4b**	**3**	**2**	**1**
Sample Number	0703257	0703258	0703259	0703260	0703261	0703262	0703263
Chironomidae	61	40.6	43.3	35.0	39.6	57.6	24.5
Caenidae	28.4	35.3	42.6	46.2	32.2	16.7	42.4
Hyalellidae	2.1	5.6	3.6	1.5	1.6	--	--
Physidae	1.1	2.8	--	--	--	--	--
Baetidae	1.1	1.3	1.5	1.7	2.0	2.5	2.3
Ceratopogonidae	0.9	4.0	0.9	6.8	7.7	1.5	--
Leptophlebiidae	0.8	2.5	0.8	3.0	10.2	3.1	2.9
Heptageniidae	0.7	--	--	0.8	--	--	1.4
Scirtidae	--	1.8	--	--	--	--	--
Coenagrionidae	--	--	1.0	--	1.9	2.3	4.5
Dryopidae	--	--	0.9	--	--	--	--
Culicidae	--	--	--	0.5	--	--	--
Leptoceridae	--	--	--	--	1.1	3.7	10.2
Hydropsychidae	--	--	--	--	--	6.0	--
Ephemeridae	--	--	--	--	--	--	2.4

Table 6
Dominant Macroinvertebrate Families (DMF) as a Percentage of the Total Number of Individuals per Station, West Fork Medicine Creek, Spring 2008

West Fork Medicine Creek Station	**6**	**5**	**4**	**3**	**2**	**1**
Sample Number	0804025	0804021	0804024	0804023	0804022	n/a
Chironomidae	75.8	51.9	43.2	38.9	32.4	n/a
Caenidae	12.0	29.7	51.2	50.0	43.8	n/a
Tubificidae	2.8	3.8	--	--	1.2	n/a
Simuliidae	2.6	0.6	0.6	0.8	11.0	n/a
Enchytraeidae	1.7	3.1	0.8	1.4	2.3	n/a
Ceratopogonidae	1.3	--	0.4	2.0	--	n/a
Sphaeriidae	1.1	--	--	--	--	n/a
Hyalellidae	--	5.8	1.4	0.8	--	n/a
Dytiscidae	--	1.1	--	--	--	n/a
Hydropsychidae	--	--	0.4	--	--	n/a
Gomphidae	--	--	--	1.4	--	n/a
Baetidae	--	--	--	--	1.2	n/a
Dryopidae	--	--	--	--	1.2	n/a

3.1.2 Physicochemical Water Parameters

In the fall, several physicochemical water parameters were notable (Table 7). The most notable parameters were dissolved oxygen of 4.13 mg/L and discharge of 0.01 cfs at station 6. Nutrients and organic indicators were detected in low concentrations. Nutrients (TN, NO_3+NO_2-N, and TP) were detected in most all stations in the fall. Total nitrogen ranged from 0.52 mg/L upstream to 0.26 mg/L downstream. Nitrate+nitrite-N was detected in three of the six stations in very low concentrations. Ammonia-N was not detected at any station in the fall. Chloride was detected at all stations, with a high of 12.8 mg/L at station 5. Chloride increased very slightly from 8.45 mg/L at station 6 to 10.1 mg/L at station 1. Total phosphorus was found in low levels in all stations.

Table 7
Physicochemical Water Parameters for West Fork Medicine Creek (WFMC) Stations, Fall 2007

Station	WFMC 6	WFMC 5	WFMC 4a	WFMC 4b	WFMC 3	WFMC 2	WFMC 1
Date	9/18/07	9/18/07	9/18/07	9/18/07	9/19/07	9/19/07	9/19/07
Sample Number	0710231	0710232	0710233	0710234	0710235	0710236	0710237
pH (Units)	7.3	7.9	7.9	--	7.5	7.6	7.7
Temperature (C°)	20.0	20.0	24.0	--	18.5	19.0	22.0
Conductivity (uS)	413	451	512	--	454	456	465
Dissolved O_2	**4.13**	5.57	9.64	--	6.10	6.41	6.51
Discharge (cfs)	0.01	0.09	0.22	--	1.83	2.89	1.32
Turbidity (NTUs)	17.7	3.91	3.95	5.82	9.57	18.4	14.3
Total Nitrogen	0.52	0.40	0.33	0.29	0.32	0.26	0.26
Nitrate+Nitrite-N	0.01	<0.01	<0.01	<0.01	0.02	0.02	0.01
Ammonia-N	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Chloride	8.45	12.8	10.3	10.2	9.28	9.71	10.1
Total Phosphorus	0.07	0.03	0.04	0.02	0.03	0.03	0.02

(Units mg/L unless otherwise noted; **Bold**=Out of WQS acceptable range or trend; 4a and 4b=QC Duplicates)

In the spring, several physicochemical water parameters were notable (Table 8). Discharge was nearly three times higher at station 4 than either of the upstream stations. Turbidity at station 4 was 175 NTU, as compared to any of the remaining stations near 30 NTU. Total nitrogen was detected at all stations, ranging from 0.93 mg/L to 0.80 mg/L, with a high of 1.06 mg/L at station 5. Nitrate+nitrite-N was detected at all stations with a high of 0.59 mg/L at station 5. Ammonia was detected at low levels in four of the five stations, excluding station 3. Total phosphorus ranged from 0.09 mg/L to 0.07 mg/L. Chloride ranged from 14.8 mg/L to 12.6 mg/L, with a high of 16.6 mg/L at station 5.

Table 8
Physicochemical Water Parameters for West Fork Medicine Creek (WFMC) Stations, Spring 2008

Station	WFMC 6	WFMC 5	WFMC 4	WFMC 3	WFMC 2	WFMC 1
Date	3/27/08	3/26/08	3/27/08	3/26/08	3/26/08	n/a
Sample Number	0803524	0803520	0803523	0803522	0803521	n/a
pH (Units)	7.94	8.13	7.86	8.07	7.96	n/a
Temperature (C°)	7.0	9.0	7.0	13.0	12.0	n/a
Conductivity (uS)	344	350	336	382	378	n/a
Dissolved O_2	11.8	10.8	11.6	9.68	10.2	n/a
Discharge (cfs)	4.4	7.81	**22.0**	21.2	26.5	n/a
Turbidity (NTUs)	33.8	15.6	**175**	25.6	37.7	n/a
Total Nitrogen	0.93	1.06	0.70	0.87	0.80	n/a
Nitrate+Nitrite-N	0.40	0.59	0.40	0.50	0.47	n/a
Ammonia-N	0.07	0.07	0.06	<0.03	0.05	n/a
Chloride	14.8	16.6	12.3	13.3	12.6	n/a
Total Phosphorus	0.09	0.08	0.07	0.07	0.07	n/a

(Units mg/L unless otherwise noted; **Bold**=Out of WQS acceptable range or trend)

3.2 Diurnal Dissolved Oxygen Study

In the fall and spring biological assessments, dissolved oxygen was recorded below WQS criterion only during the fall sampling season. Conducting a discrete study in the summer should capture the most extreme dissolved oxygen concentrations. The separate study included diurnal fluctuations and comparisons of dissolved oxygen concentrations with WQS criterion. Water temperature ranged from 22° to 33°C.

During the summer 2007 period the dissolved oxygen concentrations exhibited an upward trend from morning to afternoon at all stations (Table 9; Figure 4). Three stations were below WQS criterion (5.0 mg/L) during one period and one continued below during the next period. Station 6 ranged from 3.46 to 9.81 mg/L and was below the WQS criterion during the 0750-0935 time period. Station 5 ranged from 3.67 to 7.14 mg/L and was below WQS criterion during the 0750-0935 and 1020-1215 time periods. Station 2 ranged from 4.94 to 8.36 mg/L and was below WQS criterion during the 0750-0935 time period. All other stations ranged above WQS criterion during all time periods.

The dissolved oxygen range for the total stream reach was observed by combining all stations within a time period (Table 9; Figure 5). The dissolved oxygen concentrations ranged between 3.4 and 6.3 mg/L during the 0750-0935 time period, with three readings below WQS criterion (stations 6, 5, and 2). During the 1020-1215 time period dissolved oxygen ranged from 3.6 to 8.0 mg/L, with station 2 remaining below WQS criterion. Dissolved oxygen ranged from 6.1 to 9.8 mg/L during the 1225-1410 time period and

from 6.9 to 8.5 mg/L during the 1510-1645 time period. Dissolved oxygen concentrations increased throughout the day at all stations.

Table 9
Dissolved Oxygen and Temperature Time Series by Station,
August 1 and 2, 2007

Station	Date	Time	Dissolved Oxygen	Temperature
6	8/2/2007	0750	3.46	22
6	8/2/2007	1020	6.39	24
6	8/1/2007	1225	9.81	31
6	8/1/2007	1510	7.81	30.5
5	8/2/2007	0805	3.74	24
5	8/2/2007	1035	3.67	24
5	8/1/2007	1245	6.12	28
5	8/1/2007	1520	7.14	30
4	8/2/2007	0820	6.36	22
4	8/2/2007	1107	8.05	25
4	8/1/2007	1305	7.89	31.5
4	8/1/2007	1540	7.56	33
3	8/2/2007	0848	5.94	23
3	8/2/2007	1125	6.54	25
3	8/1/2007	1325	7.21	30.5
3	8/1/2007	1600	6.91	32
2	8/2/2007	0915	4.94	24.5
2	8/2/2007	1152	5.08	24.5
2	8/1/2007	1350	6.62	28
2	8/1/2007	1625	8.36	30
1	8/2/2007	0935	5.41	26.5
1	8/2/2007	1215	6.57	27
1	8/1/2007	1410	7.16	29
1	8/1/2007	1645	8.56	31

Figure 4: Dissolved Oxygen Concentrations by Station Over Time

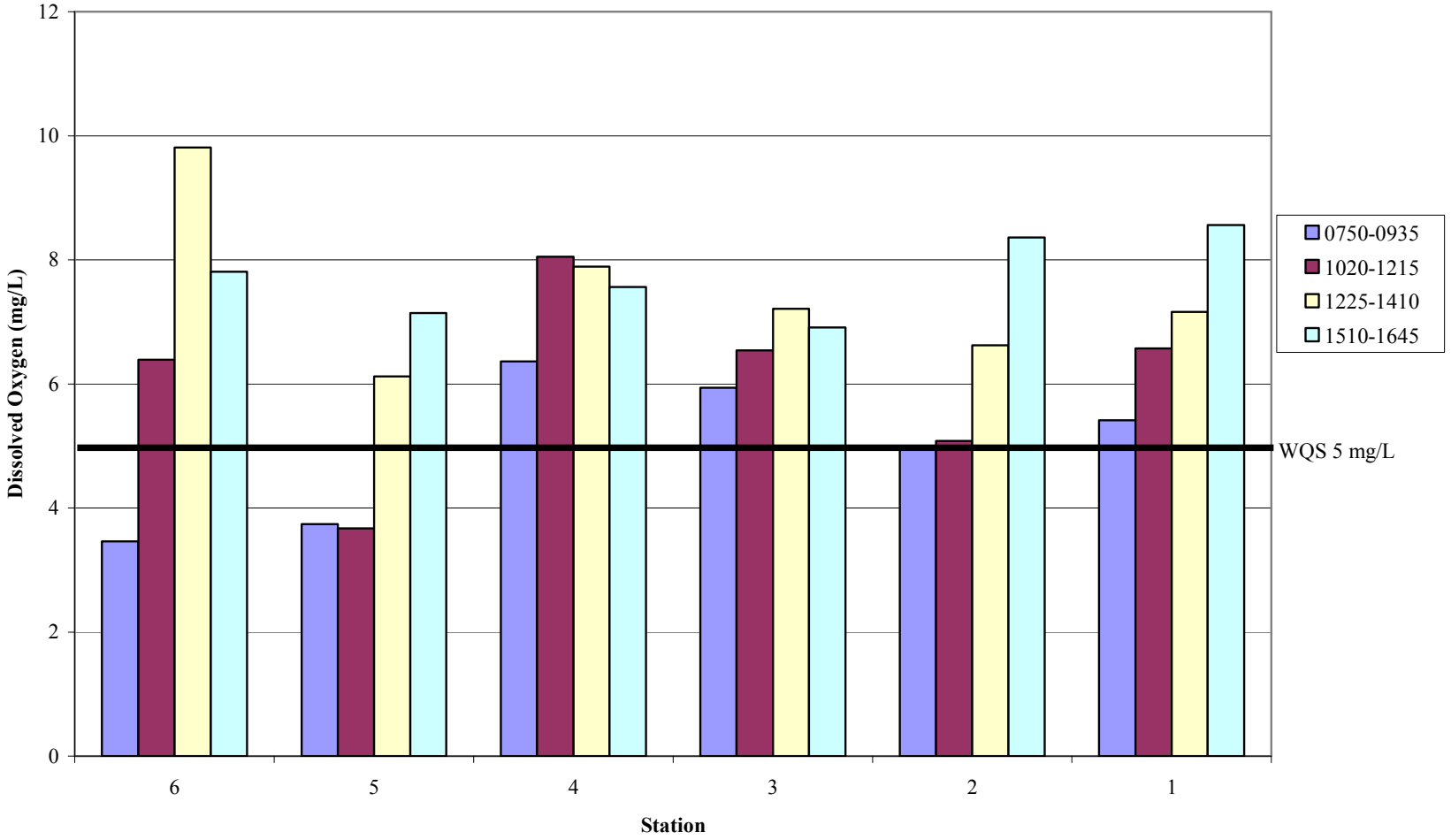
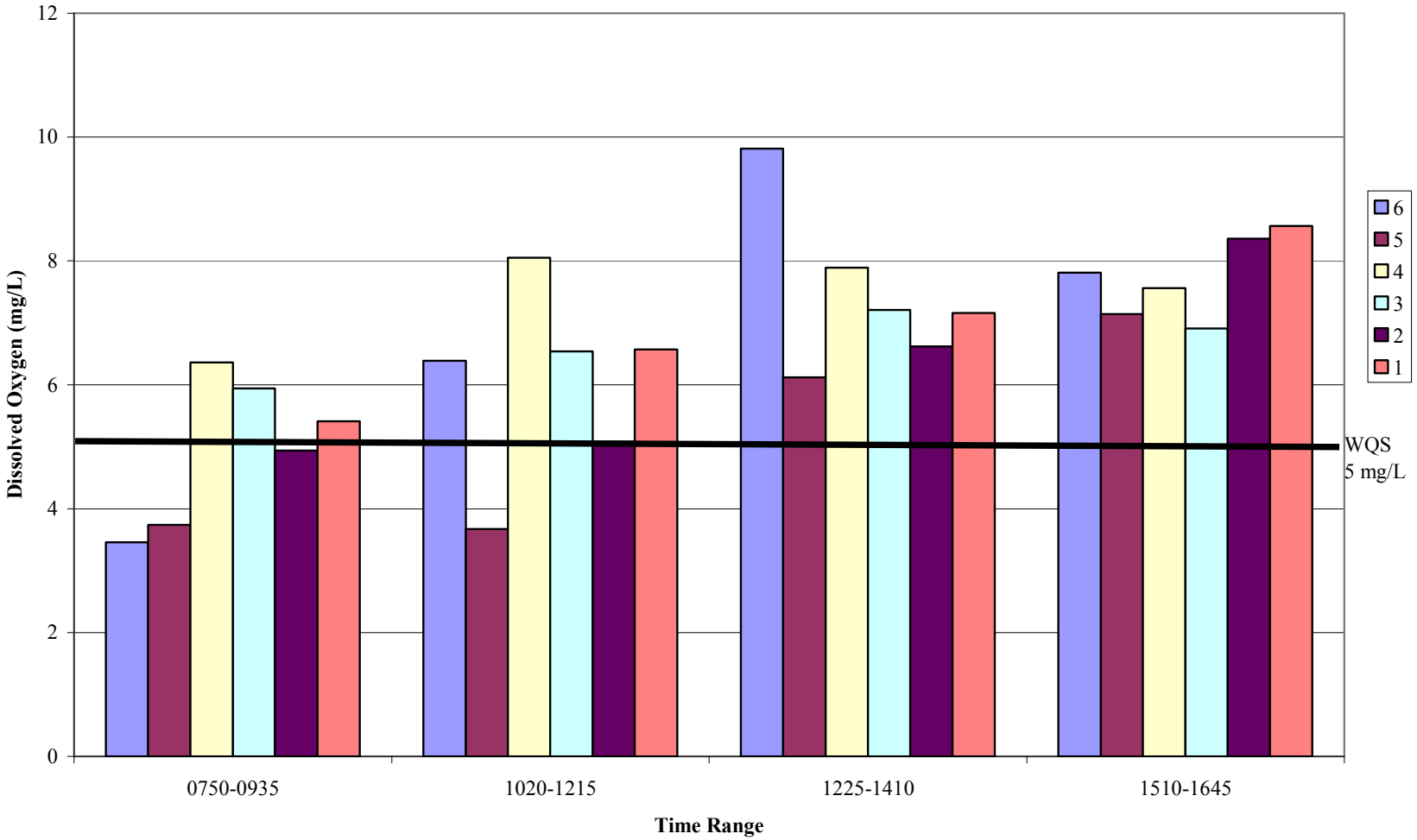


Figure 5: Dissolved Oxygen Concentrations by Time per Station



4.0 Discussion

The section includes discussion of the macroinvertebrate community integrity and water quality within the WFMC study area.

4.1 Macroinvertebrate Community

The macroinvertebrate community was examined using MSCI scores, individual metric scores, and dominant macroinvertebrate families.

All sampling stations were fully supporting for AQL during the fall, indicating they were similar to reference stations. In the fall, the BI was slightly higher than the optimum in the upstream stations 6 through 4, suggesting that there may have been some organic influence on the community structure. The BI score of 7.2 found at the three upstream stations was borderline to the optimum BIOREF score, so each station received a score of 3 for that metric. The separation between the upstream BI score was too close to the optimum BIOREF score to indicate that the upstream stations were influenced by organic pollution. However, the BIs were much lower and within the optimum BIOREF range at stations 3, 2, and 1 downstream. This indicated that the downstream community was not affected by organic influences during this study. Organic pollution did not obviously influence the communities at any station in the fall.

In the spring, MSCI and individual metrics identified a community composition that was not of the quality of reference streams within the EDU. Four of the five stations were partially supporting for AQL, with station 2 being the only fully supporting station. At most stations TR, EPTT, and SDI were low, indicating that quantity, quality, and diversity were low and with the BI indicating that the community was comprised of taxa that were tolerant to organic influences. The BI was slightly higher than the optimum range from station 6 to station 3 in the fall, illustrating a possible organic influence in the upstream stations. Station 2 was within the optimum BIOREF range, indicating that the influence was not as prevalent downstream. Figure 3 identifies potential organic influences (i.e. red triangles) within the watershed.

Dominant macroinvertebrate families generally explain how individual metric scores followed the fully supporting trend in the fall. Chironomids and caenid mayflies dominated the communities during the fall but other generally intolerant taxa were found as well. Baetid mayflies were among the dominant taxa at all stations, slightly increasing downstream. Also, leptocerid caddisflies and ephemerid mayflies were among the dominants in the lower stations. Baetids, leptocerids, and ephemerids are generally intolerant to organic pollution and disturbance. The presence of these taxa generally explains why the scores were higher and better downstream in the fall.

The dominant families were slightly different at most stations in the spring. Chironomids and caenid mayflies were again dominant, as was found in the fall. However, tubificid and enchytraeid worms were also among the dominant families. Baetid mayflies were only dominant in station 2, as opposed to all stations as found in the fall. The

chironomids, tubificids, and enchytraeid worms are generally tolerant to disturbance and contributed to the lower scores of most stations. Conversely, the generally intolerant baetid mayflies were only dominant at station 2. As a result, the EPTT and BI scores were within the optimum BIOREF scoring range at station 2 and the MSCI was fully supporting the beneficial use of AQL. Higher BI scores potentially indicate there is an organic influence or disturbance that negatively impacted the macroinvertebrate community.

4.2 Water Quality

Dissolved oxygen was low at upstream stations in the fall. Dissolved oxygen was approximately 4 mg/L at station 6. Concentrations were slightly higher and above WQS at station 5 (5.5 mg/L) and increased downstream. Discharges were also lowest at stations 6 and 5 and may have been responsible for the decreased oxygen concentrations. Low flow and low dissolved oxygen concentrations may have influenced upstream communities. As noted earlier, macroinvertebrate populations had less than optimum BIs at upper stations in the fall but were still considered fully supporting.

Nutrients such as total nitrogen, nitrate+nitrite as nitrogen, and total phosphorus were detected in very low concentrations in some stations in the fall. Chloride was also detected near 13 mg/L at station 5. The presence of nutrients and chloride may indicate that there may be an organic influence in or upstream of the upstream stations. The low levels suggest that organic input was not a major influence on the community composition during sampling, as was identified in the macroinvertebrate results. SCI scores were lower upstream, but still fully supporting the beneficial use AQL.

In the spring, total nitrogen, ammonia-N, and total phosphorus were slightly higher upstream than downstream, indentifying a potential organic enrichment. Chloride was also higher upstream than downstream, indicating a possible organic influence upstream from all stations. Even though nutrient concentrations were low it is somewhat consistent with lower BI scores upstream in the spring, identifying stress on the community from organic pollution. Chloride did not exceed WQS during sampling. Turbidity and discharge were notable. Turbidity was 175 NTU at station 4 and discharge was 22 cfs, approximately three times higher than the next upstream station. Heavy rain overnight and during sampling (3/27/08) accounted for the increase in turbidity and discharge at station 4. Overall, relationships were not obvious and impairment in the spring may be due to other stressors.

4.3 Other Source of Stress

An alternate explanation for depressed MSCI scores at four of the five stations in the spring may be high flows. Water level and discharge at the nearest USGS Medicine Creek stream gage was used as an indicator of flow in the WFMC watershed (Appendix C). A high flow event occurred on March 3, 2008, approximately three weeks prior to our visit on March 27 and 28, 2008. The stream water level reached 15 feet with a discharge of nearly 10,000 cfs less than a month before our spring biological

assessment was conducted. This is significantly higher than normal flow of approximately three feet and median discharge of approximately 100 cfs. High flow and the resulting scour of benthic substrate are suggested as a potential cause for lower MSCI scores.

4.4 General Observations

General observations indicate that high flow conditions may have altered the stream habitat and consequently the macroinvertebrate composition in the spring. Stream banks had collapsed in many locations within each station indicating that there had been a high flow event. Substrate was comprised of unconsolidated and deep loose sand indicating freshly deposited material. Substrate observed during the fall survey was consolidated sand in the majority of the study area, which was colonized and probably more habitable for macroinvertebrates. The disturbance appeared to have happened just prior to our visit because soil was still falling into the stream from banks and exposed root wads during our visit. General observations are also consistent with those of the 2004 biological assessment where recent high flow was suggested to be a cause for low scores (MDNR 2005a). It appears that high flow events in the spring are common sources of disturbance to macroinvertebrate communities.

Altered habitat has apparently affected the macroinvertebrate community in WFMC and may also affect fish communities in WFMC. Stream depth is changing with the moving sand substrate. Fish habitat may not be present as pools are shallow and frequently changing. A fish community evaluation and biological assessment may determine if habitat is suitable.

4.5 MSCI Pass/Fail Ratio

The MSCI pass/fail ratio decreased from the 2003-2005 study to this study. As mentioned earlier, the ratio for 2003-2005 was 89% supporting and 11% not supporting. When the 2003-2005 study scores are combined with the 2007-2008 study scores the new pass/fail ratio is 79% supporting and 21% not supporting with 23 stations fully supporting and 6 stations partially supporting the beneficial use AQL. The EDU MSCI pass/fail ratio is also 79% supporting and 21% not supporting.

4.6 Dissolved Oxygen Study

Dissolved oxygen concentrations fluctuated during the day in the summer. Dissolved oxygen concentrations in the stream ranged from a low of 3.7 mg/L to a high of 9.8 mg/L. Early morning oxygen concentrations were lower than afternoon concentrations. Three stations (6, 5, and 2) had concentrations below the WQS criterion during the 0750-0935 time period. Only station 5 remained below the WQS criterion during the 1020-1215 time period. All stations were above the WQS criterion by 1225 despite warming afternoon temperatures. Water temperatures ranged from 22° to 33°C. Fluctuations follow a photosynthetic oxygenation dependant trend. These fluctuations, from below to above the present WQS criterion of 5.0 mg/L, appear to be a common and natural occurrence in streams in this and other prairie dominant EDUs. Although flow was not

measured during this study during the summer, minimum WQS for dissolved oxygen in these and other glide/pool dominant streams may not accurately reflect summer low flow natural conditions.

5.0 Conclusion

The objectives were met. The quality of the macroinvertebrate community was measured and found to be depressed in the spring, possibly due to upstream organic influences or excessive flow and change in habitat conditions. Water quality was evaluated. The dissolved oxygen concentrations for the mid-summer time frame were documented.

Macroinvertebrate communities were not similar to the BIOREF streams and metrics identified impairment at four of five stations sampled in the spring. Fall communities were similar. Water quality (dissolved oxygen) was not similar from upstream to downstream in the fall, but was similar and within WQS at all stations in the spring. Nutrients and indicators of organic influences were present in low amounts in the fall and spring. Daily dissolved oxygen concentrations in the summer fluctuated during the day from below to above the minimum WQS criterion.

6.0 Recommendations

1) Evaluate the quality of the fish community.

2) Conduct biological assessment using fish community indices.

3) Re-evaluate minimum WQS dissolved oxygen concentrations in Ecological Drainage Units dominated by glide/pool stream types.

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Appendix A

Missouri Department of Natural Resources
Bioassessment and Stressor Study Proposal
West Fork Medicine Creek, Mercer and Grundy Counties
July 27, 2007

Missouri Department of Natural Resources
Bioassessment and Stressor Study Proposal
West Fork Medicine Creek, Mercer and Grundy Counties
July 27, 2007

Background

West Fork Medicine Creek (WFMC) enters Missouri from Iowa in Mercer County. The stream flows approximately 40 miles before reaching its confluence with East Fork Medicine Creek, southeast of Galt, Missouri, where they are then called Medicine Creek. West Fork Medicine Creek is a class P stream, which identifies it as a permanently flowing stream. West fork Medicine Creek has beneficial uses of: protection of aquatic life and human health –fish consumption (AQL); livestock and wildlife watering (LWW); and whole body contact (WBC), category B. Approximately 40 miles of West Fork Medicine Creek is on the 2004/2006 Section 303(d) list of impaired waters (MDNR 2005c) with potential impairment from unknown sources.

Several biological assessments have been conducted on the stream since 1996 to the spring of 2005. The earliest macroinvertebrate study on WFMC was from 1996-2000, which was conducted by a consulting firm as a result of a consent decree after an environmental accident in the watershed. Data from this study are housed with the Missouri Department of Natural Resources (**MDNR**), Aquatic Bioassessment Unit. The MDNR first conducted an aquatic biological assessment during the fall of 2003 and spring of 2004. The project continued in the fall of 2004 and ended in the spring of 2005. Data from the 2003 through 2005 studies were compiled in a biological assessment report (MDNR 2005a).

As a result of those studies, the Macroinvertebrate Stream Condition Index (**MSCI**; MDNR 2003e) scores were identified and semi-quantitative biological support categories were assigned to each station and compared to reference stations. The criterion for further studies or continued 303(d) listing of longer segments of streams is a comparison of full to partial or non (pass/fail) support MSCI scores between test and reference streams. The acceptable MSCI full/partial or non support (pass/fail) ratio for reference streams the Central Plains/Grand/Chariton Ecological Drainage Unit (**EDU**) is 79:21. The test stream in that EDU must match that ratio or additional studies will be required. Interestingly, the ratio for the 2003-2005 study was 89:11. However, when 2003-2005 was combined with the 1996-2000, the biological support ratio was 73:27. Therefore, additional studies must be conducted on West Fork Medicine Creek, in Mercer and Grundy counties.

Therefore, it is our intention to conduct an additional biological assessment and stressor study on West Fork Medicine Creek, Mercer and Grundy Counties. The study will be conducted by the Field Services Division (**FSD**), Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**), and Chemical Analysis Section (**CAS**).

Objectives

1. Assess the biological and water quality of West Fork Medicine Creek.

2. Identify (diel) dissolved oxygen range.

Tasks

1. Conduct a biological assessment on West Fork Medicine Creek.

2. Conduct additional dissolved oxygen studies at stations.

Null Hypotheses

Biological metrics and MSCI scores will be similar between stations and to wadeable/perennial stream biological criteria.

Physicochemical water quality will be similar at all stations and parameters will meet the Water Quality Standards (s) of Missouri (MDNR 2005c).

Dissolved oxygen concentrations will be similar between stations and in acceptable levels (s) throughout the day.

Study Design

Study Area: The West Fork Medicine Creek study area includes approximately 40 miles of the 303(d) listed section (Figure 1). Six stations included in this project are in approximately the same locations that were used in either 2003-2004 or 2004-2005 studies (Table 1).

Biological Assessment

A biological assessment consists of macroinvertebrate community and physicochemical water evaluation. An additional dissolved oxygen study will be conducted in the summer of 2007.

Macroinvertebrate Sampling and Analyses: As identified in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP,** MDNR 2003e), macroinvertebrates will be sampled from three specific habitats. These target habitats are based on stream type (MDNR 2003e). West Fork Medicine Creek is considered a glide/pool dominant stream in which non-flowing water over depositional substrate, snag, and rootmat habitats will be sampled. Macroinvertebrates will be subsampled according to the SMSBPP and identified to specific taxonomic levels (MNDR 2005b) in order to calculate metrics in a standardized fashion (MDNR 2003e; MDNR 2005b).

Macroinvertebrate community data will be analyzed using three strategies. Macroinvertebrate Stream Condition Index (**MSCI**) scores, individual biological criteria metrics, and dominant macroinvertebrate families (**DMF**) will be examined and compared from upstream to downstream. The biological support ratio will be calculated and recommendations given.

Physicochemical Water Sampling and Analyses: Physicochemical water samples were handled according to the appropriate MDNR, ESP Standard Operating Procedure (**SOP**) and/or Project Procedure (**PP**) for sampling and analyzing physicochemical water samples. Results for physicochemical water parameters will be examined by season and station.

Fall 2005 and spring 2006 physicochemical water parameters will either be sampled by field measurements or collected as grab samples. Water will be sampled and handled according to the SOP MDNR-FSS-001 Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2008). All samples will be kept on ice during transport to ESP. Water samples will either measured *in-situ* or analyzed at the Environmental Services Program laboratory. Temperature (C^o), pH, conductivity (uS), dissolved oxygen (mg/L), and discharge (cubic feet per second-**cfs**) will be measured in the field. Turbidity (NTU) will be measured and recorded in the WQMS biology laboratory. The ESP, Chemical Analysis Section (**CAS**) in Jefferson City, Missouri, conducted analyses for ammonia-nitrogen (mg/L), nitrate+nitrite-nitrogen (mg/L), total nitrogen (mg/L), chloride (mg/L), and total phosphorus (mg/L).

Physicochemical water parameters will be compared between stations from upstream to downstream, as well as with Missouri's WQS (MDNR 2005c). Interpretation of acceptable limits in the WQS may be dependent on a stream's classification and its beneficial-use designation (MDNR 2005c). West Fork Medicine Creek is a class "P" stream, with designated uses for AQL, LWW, and WBC-category B. Furthermore, acceptable limits for some parameters, such as dissolved metals, may be dependent on the rate of exposure. These exposure or toxicity limits are based on the lethality of a toxicant given long-term exposure (chronic toxicity, **c**) or short-term exposure (acute toxicity, **a**).

Discharge: Stream flow was measured using a Marsh-McBirney Flowmate™ flow meter at each station. Velocity and depth measurements were recorded at each station according to SOP MDNR-WQMS-113 Flow Measurement in Open Channels (MDNR 2003b**).**

Discrete Dissolved Oxygen and Temperature Observations: Discrete dissolved oxygen measurements will be included in this study. Six stations will be sampled for dissolved oxygen and temperature between July and September 2007. Dissolved oxygen measurements will be measured using a YSI hand held field meter (MDNR 2002). Temperature will be measured in conjunction with all oxygen samples (MDNR 2003a). Oxygen and temperature readings will be taken in the morning and afternoon at each station according to recommendations in the Wasteload Allocation/Special Stream Studies Project Procedure (MDNR 2003f).

Table 1
Location and Descriptive Information for Proposed Stations on West Fork Medicine Creek

Station	County	TRS; Location	Description	* Equates to 03-04 Station **04-05 Station**
WFMC 6	**Mercer**	SW ¼ sec. 05, T. 65 N., R. 22 W. Lat. 40 27 31.8 Long. –93 24 12.3	Upstream bridge MO hwy 136	4
WFMC 5	Mercer	SE ¼ sec. 19, T. 65 N., R. 22 W. Lat. 40 25 08.6 Long. –93 24 18.4	Downstream bridge VanDyke C.A.	3
WFMC 4	Mercer	NE ¼ sec. 20, T. 64 N., R. 22 W. Lat. 40 20 20.9 Long. –93 23 35.2	Downstream bridge Intrepid Road	2
WFMC 3	Mercer	SW ¼ sec. 04, T. 63 N., R. 22 W. Lat. 40 17 03.2 Long. –93 22 54.0	Upstream bridge Jukebox Street	**4**
WFMC 2	Grundy	NW ¼ sec. 04, T. 62 N., R. 22 W. Lat. 40 12 24.7 Long. –93 22 42.5	Downstream 90th Street bridge	**3**
WFMC 1	Grundy	NW ¼ sec. 33, T. 62 N., R. 22 W. Lat. 40 07 51.0 Long. –93 22 45.1	Upstream bridge MO hwy 6	1

***** Station number approximates with station in either 2003-2004 or **2004-2005** (**bold**) studies (MDNR 2005a).

Data Recording and Analyses: Macroinvertebrate data will be entered in a Microsoft Access database in accordance with Quality Control Procedures for Data Processing, MDNR-WQMS-214 (MDNR 2003c). Data analysis is automated within the Access database. A total of four standard metrics will be calculated for each sample reach according to the SMSBPP: Taxa Richness (TR); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Diversity Index (SDI). Additional metrics, such as Quantitative Similarity Index for Taxa (QSI-T) may be used to discern differences in taxa between control and impacted stations.

Water quality data will be entered in the Laboratory Information Management System (LIMS) database. Data analysis will be summarized and interpreted using Microsoft Access and Excel software as well as Jandel Scientific software, SigmaStat.

Data Reporting: Results of the study will be summarized and interpreted in report format.

Quality Control: Quality control measures were conducted in accordance with MDNR SOPs and Project Procedures.

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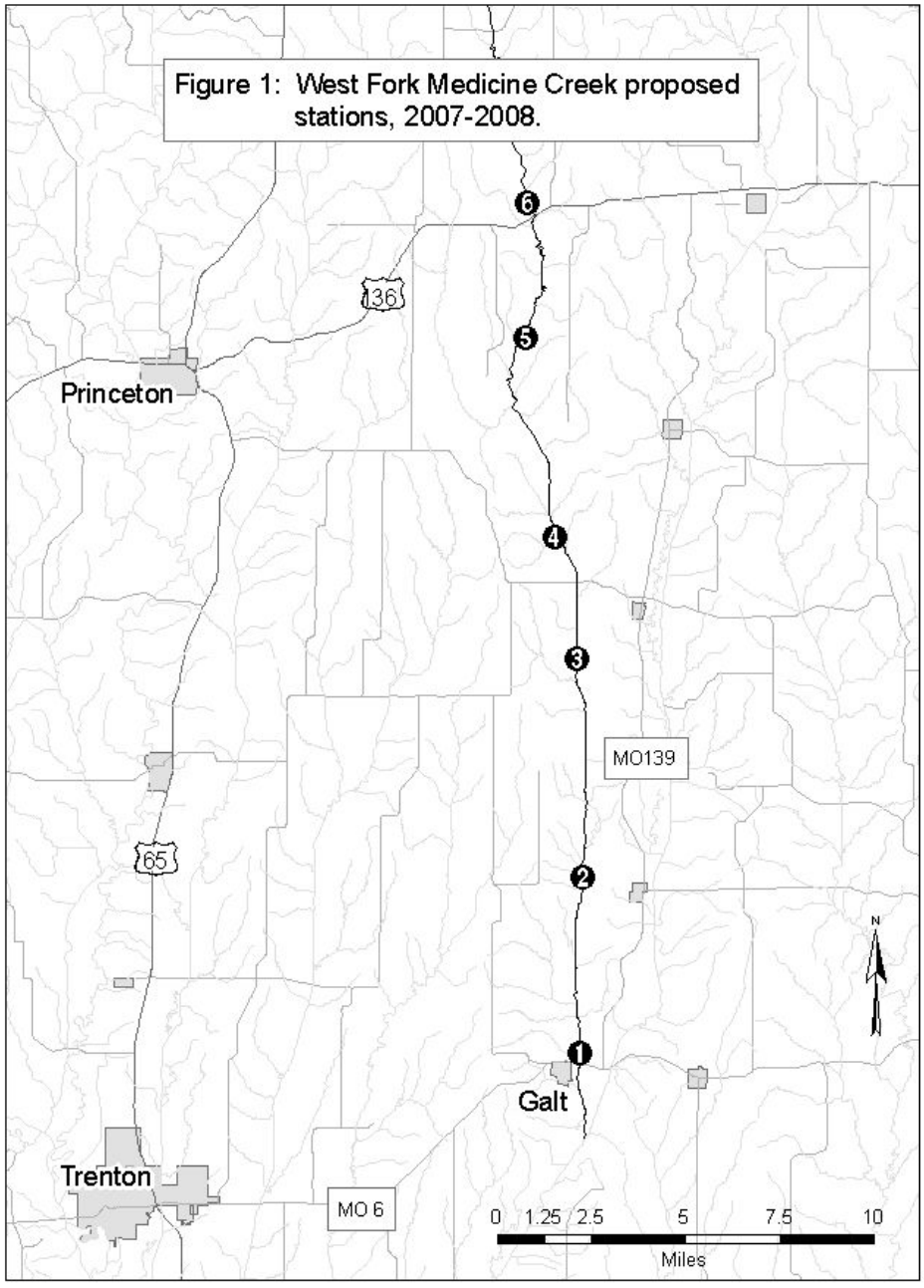
Missouri Department of Natural Resources. 2005b. Taxonomic levels for macroinvertebrate identification. Field Services Division, Environmental Services Program. Water Quality Monitoring Section, P.O. Box 176, Jefferson City, Missouri, 65102. 30pp.

Missouri Department of Natural Resources. 2005c. Title 10. Rules of Department of Natural Resources Division 20-Clean Water Commission, Chapter 7-Water Quality. 10 CSR 20-7.031 Water Quality Standards. pp. 10-136.

Attachment: Figure 1



Appendix B

Macroinvertebrate Bench Sheet Report for West Fork Medicine Creek
Fall 2007 and Spring 2008

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703257], Station 6, Sample Date: 9/18/2007 11:20:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		17	5
COLEOPTERA			
Dubiraphia		2	
Enochrus			1
Helichus lithophilus		3	
Scirtidae	1		2
DECAPODA			
Orconectes medius		1	
Orconectes virilis		1	
DIPTERA			
Ablabesmyia	21	23	10
Ceratopogoninae	2		2
Chironomus	1		1
Cladotanytarsus	70	3	6
Corynoneura	4		
Cryptochironomus	4		1
Cryptotendipes	3		
Dicrotendipes	22	37	84
Diptera			1
Forcipomyiinae	2		4
Glyptotendipes	1	33	55
Labrundinia	1	2	
Nanocladius	5		3
Parachironomus	1		
Paracladopelma	1		
Paratanytarsus	3	5	5
Polypedilum	1	1	
Polypedilum convictum	1		
Polypedilum fallax grp			2
Polypedilum halterale grp	6		1
Polypedilum illinoense grp	20	18	23
Polypedilum scalaenum grp	3	2	3
Procladius		1	1
Rheotanytarsus		1	1
Stempellinella	16		
Stenochironomus			10
Tanytarsus	68	29	18
Tribelos			1
EPHEMEROPTERA			
Caenis latipennis	104	134	56

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703257], Station 6, Sample Date: 9/18/2007 11:20:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Callibaetis		2	
Heptageniidae	1		
Hexagenia limbata	1		
Leptophlebiidae	1	8	
Paracloeodes	1		
Procloeon	3	1	4
Pseudocloeon	1		
Stenacron	5	1	
Stenonema femoratum	1		
HEMIPTERA			
Corixidae	3		
Gerridae			1
LEPIDOPTERA			
Pyralidae	1		
LIMNOPHILA			
Physella	1	11	
MEGALOPTERA			
Sialis		-99	
ODONATA			
Gomphidae	1		
Progomphus obscurus	2		
TRICHOPTERA			
Chimarra	1		
Oecetis	3		
Triaenodes		1	
TUBIFICIDA			
Enchytraeidae			1
Limnodrilus hoffmeisteri	1		
Tubificidae		1	1
UNIONIDA			
Unionidae	-99		
VENEROIDEA			
Sphaeriidae	2	4	

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703258], Station 5, Sample Date: 9/18/2007 12:45:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina		2	
AMPHIPODA			
Hyalella azteca	1	42	13
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
COLEOPTERA			
Helichus lithophilus		4	3
Neoporus		1	
Scirtidae		17	1
Stenelmis		1	
Tropisternus		-99	
DIPTERA			
Ablabesmyia	9	4	3
Anopheles		2	1
Ceratopogoninae	8	6	1
Chironomus			1
Cladotanytarsus	40	4	10
Cricotopus/Orthocladius		1	
Cryptochironomus	2		1
Cryptotendipes	3		
Dicrotendipes	13	3	32
Endochironomus		2	1
Forcipomyiinae		1	24
Glyptotendipes		7	47
Harnischia	1		
Hemerodromia		1	
Labrundinia		2	4
Mesosmittia		1	
Nanocladius	1	2	2
Parachironomus	1	3	
Paracladopelma	3		
Parakiefferiella			2
Paratanytarsus	3	5	7
Polypedilum			4
Polypedilum halterale grp	7	1	
Polypedilum illinoense grp	5	18	54
Polypedilum scalaenum grp			1
Procladius	1		
Rheotanytarsus		2	

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703258], Station 5, Sample Date: 9/18/2007 12:45:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Stempellinella	14		1
Tanytarsus	29	5	35
Thienemannimyia grp.		3	1
Tipulidae			1
Tribelos		2	1
undescribed Empididae		2	
EPHEMEROPTERA			
Brachycercus	3		
Caenis latipennis	181	101	67
Leptophlebiidae		25	
Paracloeodes			11
Procloeon	2		
Stenacron	1	2	
HEMIPTERA			
Belostoma		-99	
Corixidae	2		
Metrobates		1	
LIMNOPHILA			
Physella		25	3
LUMBRICULIDA			
Lumbriculidae		4	
ODONATA			
Boyeria		-99	
Dromogomphus	-99		
Enallagma		3	1
Erythemis			1
Ischnura		1	1
Libellula	-99		
Progomphus obscurus	-99		
TRICHOPTERA			
Nectopsyche	1	2	1
Oecetis		1	
TUBIFICIDA			
Enchytraeidae		7	
Tubificidae	2	5	
UNIONIDA			
Unionidae		-99	
VENEROIDEA			
Sphaeriidae	2	3	

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703259], Station 4a, Sample Date: 9/18/2007 3:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		43	
COLEOPTERA			
Berosus			1
Dubiraphia	4		
Helichus lithophilus		11	
Neoporus			1
Scirtidae		4	1
DIPTERA			
Ablabesmyia	11	16	7
Anopheles		8	1
Ceratopogoninae	2	1	
Chironomus	11		
Chrysops		2	
Cladotanytarsus	26	4	11
Cricotopus/Orthocladius			1
Cryptochironomus	5		1
Cryptotendipes	18	1	1
Dicrotendipes	8	16	87
Forcipomyiinae			8
Glyptotendipes		6	4
Labrundinia	2	16	3
Limonia			1
Nanocladius	1	3	
Parachironomus	1		
Paralauterborniella	4		
Paratanytarsus	1	9	
Phaenopsectra			2
Polypedilum		4	4
Polypedilum halterale grp	5		
Polypedilum illinoense grp	9	30	9
Polypedilum scalaenum grp	7		1
Procladius	13		3
Rheotanytarsus		4	
Stelechomyia			1
Stempellinella	38	3	3
Stenochironomus			6
Tanytarsus	38	36	14
Thienemannimyia grp.		4	2
Tribelos		1	4

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703259], Station 4a, Sample Date: 9/18/2007 3:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
EPHEMEROPTERA			
Brachycercus	5		
Caenis hilaris			1
Caenis latipennis	142	245	114
Callibaetis	1	1	2
Hexagenia	2		4
Leptophlebiidae		10	
Paracloeodes	3	4	2
Procloeon	1	2	2
Stenacron	1	1	1
Tricorythodes		2	
HEMIPTERA			
Corixidae	1		
LIMNOPHILA			
Ferrissia			1
Physella	1		
ODONATA			
Argia		1	1
Calopteryx		3	
Enallagma	2	3	1
Gomphidae			1
Gomphus	1		
Ischnura		3	1
Progomphus obscurus	1		
RHYNCHOBDELLIDA			
Glossiphoniidae			1
TRICHOPTERA			
Nectopsyche	1	6	
TUBIFICIDA			
Enchytraeidae		3	
Tubificidae	1	5	
VENEROIDEA			
Sphaeriidae	2		

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703260], Station 4b, Sample Date: 9/18/2007 3:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		13	2
BRANCHIOBDELLIDA			
Branchiobdellida		2	
COLEOPTERA			
Berosus			2
Enochrus			1
Helichus lithophilus			3
Neoporus			1
Paracymus		1	
Scirtidae		2	1
DECAPODA			
Orconectes medius		-99	
DIPTERA			
Ablabesmyia	25	5	6
Anopheles		2	3
Ceratopogoninae	2		1
Chironomus	8		
Chrysops		1	
Cladotanytarsus	24		4
Cricotopus bicinctus	1	1	
Cryptochironomus	2		
Cryptotendipes	5		2
Dicrotendipes	11		71
Forcipomyiinae	1		62
Glyptotendipes	1	4	1
Labrundinia		4	
Nanocladius	1		
Parachironomus		2	
Paralauterborniella	2		
Paratanytarsus	2	1	
Polypedilum		1	
Polypedilum fallax grp		1	
Polypedilum illinoense grp	12	7	8
Polypedilum scalaenum grp	1		
Procladius	9		2
Stempellina	1		
Stempellinella	46		1
Stenochironomus			2
Tanytarsus	32	18	10

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703260], Station 4b, Sample Date: 9/18/2007 3:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Thienemannimyia grp.		2	
Tipula			1
Tribelos		2	
undescribed Empididae		1	
EPHEMEROPTERA			
Caenis latipennis	125	200	121
Centroptilum		1	
Hexagenia limbata	2		
Leptophlebiidae	1	28	
Paracloeodes	5		2
Procloeon	4	2	3
Stenacron			8
Stenonema femoratum			-99
Tricorythodes			1
HEMIPTERA			
Belostoma		-99	
Corixidae	1		
LIMNOPHILA			
Physella		3	1
ODONATA			
Argia		1	
Calopteryx		1	
Gomphus		-99	
Ischnura		1	
Libellula	1	1	
Progomphus obscurus	2	1	
TRICHOPTERA			
Nectopsyche		2	
TUBIFICIDA			
Tubificidae	2	3	
VENEROIDEA			
Sphaeriidae	2	-99	

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703261], Station 3, Sample Date: 9/19/2007 8:15:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		8	8
COLEOPTERA			
Dubiraphia	2	1	
Helichus lithophilus		5	
Scirtidae		2	
DIPTERA			
Ablabesmyia	3	2	8
Ceratopogoninae	2	1	1
Cladotanytarsus	43		
Cryptochironomus	3		
Dicrotendipes	10	1	43
Forcipomyiinae		2	68
Glyptotendipes		1	
Labrundinia	1	14	3
Nanocladius	2	3	
Nilothauma		1	
Paracladopelma	3		
Paratanytarsus	1	2	
Polypedilum convictum	1		1
Polypedilum halterale grp	3	1	
Polypedilum illinoense grp	14	14	43
Procladius	3		
Rheotanytarsus	7	8	1
Stempellinella	62	1	6
Stenochironomus			9
Tanytarsus	34	10	13
Thienemannimyia grp.		3	1
undescribed Empididae		4	
EPHEMEROPTERA			
Baetiscidae	2		
Caenis latipennis	104	109	95
Callibaetis		1	1
Leptophlebiidae		96	2
Paracloeodes	2	1	10
Procloeon	1	1	3
Stenacron		1	1
Tricorythodes		1	1
HEMIPTERA			
Corixidae	1		

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703261], Station 3, Sample Date: 9/19/2007 8:15:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Microvelia			1
ODONATA			
Argia		12	2
Calopterygidae	1		
Enallagma		5	
Gomphus	-99	1	
Progomphus obscurus	3		-99
TRICHOPTERA			
Nectopsyche		7	
Oecetis		1	
Triaenodes		3	
TUBIFICIDA			
Tubificidae			1
VENEROIDEA			
Sphaeriidae	1	2	

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703262], Station 2, Sample Date: 9/19/2007 10:15:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		1	
COLEOPTERA			
Berosus		2	1
Dubiraphia		9	
Helichus lithophilus		9	1
Tropisternus		-99	
DIPTERA			
Ablabesmyia	2	2	
Anopheles		1	
Ceratopogoninae	1	3	
Cladotanytarsus	47	3	
Corynoneura	1	1	
Cryptochironomus	6		
Cryptotendipes	3	1	
Dicrotendipes	3	4	20
Ephydridae		1	
Forcipomyiinae			12
Glyptotendipes		1	1
Gonomyia	2		
Hemerodromia			1
Labrundinia	1	7	2
Lipiniella	8		
Nanocladius	1		
Paracladopelma	5		
Paratanytarsus		1	
Paratendipes	3		
Pericoma		1	
Polypedilum convictum			5
Polypedilum illinoense grp	20	14	4
Polypedilum scalaenum grp	4		
Procladius	2	1	
Pseudochironomus			1
Rheotanytarsus	3	18	176
Simulium			1
Stempellina	3		
Stempellinella	138	2	3
Stenochironomus			6
Tanytarsus	19	14	25
Thienemanniella		4	6

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703262], Station 2, Sample Date: 9/19/2007 10:15:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Tribelos	1		
EPHEMEROPTERA			
Acerpenna			4
Brachycercus	4		
Caenis hilaris		2	3
Caenis latipennis	37	108	18
Hexagenia limbata	1		
Isonychia			1
Leptophlebiidae		32	
Maccaffertium terminatum			1
Paracloeodes	11	3	4
Procloeon	3	1	
Stenacron			2
Tricorythodes		8	3
HEMIPTERA			
Trepobates	1		
LIMNOPHILA			
Physella		3	
MEGALOPTERA			
Corydalus			-99
ODONATA			
Argia		15	1
Enallagma		6	
Gomphus		-99	
Ischnura		2	
Libellula	1	-99	
Macromia		-99	
Progomphus obscurus	4	-99	-99
TRICHOPTERA			
Cheumatopsyche			62
Hydroptila			2
Nectopsyche		36	1
Oecetis	1	1	
TUBIFICIDA			
Tubificidae		3	
UNIONIDA			
Unionidae	-99	-99	
VENEROIDEA			
Sphaeriidae		4	

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703263], Station 1, Sample Date: 9/19/2007 11:40:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina		8	
AMPHIPODA			
Hyalella azteca	1	8	2
COLEOPTERA			
Berosus	1	4	4
Dubiraphia	6	1	
Neoporus		3	
DIPTERA			
Ablabesmyia	1	7	8
Ceratopogoninae		7	
Cladotanytarsus	25	3	4
Cryptochironomus	10		
Cryptotendipes	27	3	1
Dicrotendipes	3	3	8
Diptera	1		
Forcipomyiinae			1
Glyptotendipes		1	1
Labrundinia	2	15	2
Parakiefferiella	1		
Paralauterborniella	4		
Paratanytarsus	1	1	
Polypedilum illinoense grp	1	10	
Polypedilum scalaenum grp	3		
Pseudochironomus	1		1
Rheotanytarsus	4	1	
Stempellinella	8	2	
Stenochironomus			2
Tabanus		3	
Tanytarsus	3	12	9
Thienemannimyia grp.		9	8
Tribelos		2	
EPHEMEROPTERA			
Acerpenna	1	2	
Baetisca lacustris	1		
Brachycercus	4	1	2
Caenis hilaris	4		1
Caenis latipennis	157	107	82
Callibaetis		6	1
Hexagenia limbata	10	2	9

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0703263], Station 1, Sample Date: 9/19/2007 11:40:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Leptophlebiidae		25	
Paracloeodes	1	1	
Procloeon	7		
Pseudocloeon		1	
Stenacron		10	2
HEMIPTERA			
Belostoma		-99	
Rheumatobates		1	
LIMNOPHILA			
Lymnaeidae		1	1
Physella		2	
ODONATA			
Argia		13	2
Enallagma	1	18	4
Gomphidae	1		
Gomphus	4	1	
Libellula		-99	
Macromia	1	-99	
Progomphus obscurus	-99		
TRICHOPTERA			
Nectopsyche	5	77	3
Oecetis	1		
TUBIFICIDA			
Tubificidae	6	4	2
VENEROIDEA			
Sphaeriidae		1	

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804025], Station 6, Sample Date: 3/27/2008 11:30:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		2	
COLEOPTERA			
Agabus		-99	
DIPTERA			
Ceratopogoninae	3	3	
Chironomidae	2	5	2
Cladotanytarsus	3		
Cricotopus/Orthocladius	7	72	40
Culex			1
Dasyheleinae		1	
Dicrotendipes	2		6
Glyptotendipes	2	2	21
Hydrobaenus	13	123	45
Ormosia		1	
Paraphaenocladius	1	5	
Paratanytarsus		5	3
Pericoma		1	
Polypedilum halterale grp	15		1
Polypedilum illinoense grp		2	
Simulium		4	10
Stictochironomus	1		
Tabanus		1	
Tanytarsus		8	8
Thienemannimyia grp.		1	
EPHEMEROPTERA			
Caenis latipennis	8	46	9
Leptophlebia		1	
Stenacron		-99	
Stenonema femoratum			1
LIMNOPHILA			
Physella		-99	
Planorbula	1		
ODONATA			
Gomphidae	-99		
PLECOPTERA			
Perlesta		2	
TRICHOPTERA			
Limnephilidae		1	
TUBIFICIDA			

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804025], Station 6, Sample Date: 3/27/2008 11:30:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Enchytraeidae	3	6	
Limnodrilus claparedianus	2		
Limnodrilus hoffmeisteri		1	
Tubificidae	9	2	1
VENEROIDEA			
Sphaeriidae	6		

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804021], Station 5, Sample Date: 3/26/2008 12:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		26	
COLEOPTERA			
Dubiraphia		1	
Helichus lithophilus		2	
Neoporus		5	
Scirtidae		1	
Tropisternus		-99	
DIPTERA			
Ablabesmyia		1	
Ceratopogoninae	1		
Chironomidae	1	2	
Cladotanytarsus	13		1
Corynoneura		1	
Cricotopus/Orthocladius	2	21	14
Cryptochironomus	1		
Cryptotendipes	1		
Dicrotendipes	1	1	12
Diplocladius		2	
Glyptotendipes	1	5	18
Hydrobaenus	2	55	17
Micropsectra		1	
Paraphaenocladius		11	5
Paratanytarsus		7	1
Polypedilum convictum		1	2
Polypedilum halterale grp	6		2
Prosimulium			3
Pseudosmittia	1		1
Stenochironomus			3
Stictochironomus	1		
Tabanus		1	
Tanytarsus	1	1	1
Thienemannimyia grp.		5	
Tipula		-99	
Tribelos	1		
Zavrelimyia		7	
EPHEMEROPTERA			
Caenis hilaris			1
Caenis latipennis	12	104	15
Stenacron		1	

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804021], Station 5, Sample Date: 3/26/2008 12:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
LIMNOPHILA			
Physella		1	
ODONATA			
Argia		1	
Gomphidae	1		
Progomphus obscurus	-99		
PLECOPTERA			
Perlesta		2	
TRICHOPTERA			
Cheumatopsyche			1
Hydroptila			1
TUBIFICIDA			
Enchytraeidae	2	8	4
Limnodrilus hoffmeisteri	3	2	
Tubificidae	7	2	3
VENEROIDEA			
Sphaeriidae	2		

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804024], Station 4, Sample Date: 3/27/2008 9:30:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		9	
DIPTERA			
Ablabesmyia		3	
Ceratopogoninae		1	2
Cladotanytarsus			1
Cricotopus/Orthocladius	2	11	53
Dicrotendipes			21
Diplocladius			1
Glyptotendipes			2
Hydrobaenus	3	21	60
Labrundinia		2	
Nanocladius		1	
Parachironomus		1	1
Paraphaenocladius		2	9
Paratanytarsus		12	9
Paratendipes	1		
Polypedilum convictum			1
Polypedilum halterale grp	7		1
Pseudochironomus			1
Rheotanytarsus			2
Simulium	2	1	1
Tabanus		-99	
Tanytarsus		2	30
Thienemanniella			2
Thienemannimyia grp.		2	2
Tipula		-99	
Tribelos		1	
EPHEMEROPTERA			
Caenis latipennis	2	231	83
Leptophlebia		-99	
Stenacron		1	1
LIMNOPHILA			
Lymnaeidae	1		
ODONATA			
Calopteryx		1	
Progomphus obscurus	2		
TRICHOPTERA			
Hydropsyche		1	2

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804024], Station 4, Sample Date: 3/27/2008 9:30:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Limnephilidae		1	
TUBIFICIDA			
Enchytraeidae	1	3	1
Limnodrilus hoffmeisteri	1		
Tubificidae	2		

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804023], Station 3, Sample Date: 3/26/2008 4:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		4	
COLEOPTERA			
Helichus basalis		1	
Helichus lithophilus		3	
Laccophilus		1	
DIPTERA			
Ceratopogoninae	1	8	1
Chironomidae		3	6
Cladotanytarsus		2	
Cricotopus bicinctus			1
Cricotopus/Orthocladius	1	13	24
Cryptochironomus	1		
Dicrotendipes			6
Diplocladius			3
Diptera	2	1	
Eukiefferiella			1
Glyptotendipes		1	4
Hydrobaenus	1	9	44
Labrundinia		1	
Limnophyes			1
Nanocladius		1	
Ormosia		1	
Paraphaenocladius	1	3	5
Paratanytarsus		3	12
Paratendipes	1		
Polypedilum convictum			1
Polypedilum halterale grp	12		
Polypedilum illinoense grp		1	
Rheotanytarsus		2	1
Simulium	1	2	1
Tanytarsus		14	1
Thienemanniella		2	
Thienemannimyia grp.		10	
Tipula		-99	
Zavrelimyia		1	
EPHEMEROPTERA			
Caenis latipennis	9	198	41
Leptophlebia		1	
Maccaffertium pulchellum		1	

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804023], Station 3, Sample Date: 3/26/2008 4:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Maccaffertium terminatum			1
HEMIPTERA			
Microvelia		1	
LUMBRICINA			
Lumbricina	1		
ODONATA			
Enallagma		1	
Gomphus		-99	
Progomphus obscurus	6	1	
PLECOPTERA			
Perlesta		3	1
TRICHOPTERA			
Cheumatopsyche		1	
Nectopsyche		1	
TUBIFICIDA			
Enchytraeidae		4	3
Tubificidae	1		
VENEROIDEA			
Sphaeriidae	1		

Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804022], Station 2, Sample Date: 3/26/2008 2:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca		2	
COLEOPTERA			
Dubiraphia			1
Helichus lithophilus		7	
Peltodytes		3	
DIPTERA			
Ceratopogoninae	1	2	1
Chironomidae	1	2	7
Cricotopus/Orthocladius		26	26
Dicrotendipes		1	4
Diplocladius			2
Gonomyia		1	
Hydrobaenus	8	37	22
Paracladopelma	1		
Paraphaenocladius		3	1
Paratanytarsus		7	4
Paratendipes	2		
Polypedilum convictum		1	1
Polypedilum halterale grp	1		
Rheotanytarsus		1	2
Simulium	1		59
Stenochironomus			1
Tanytarsus		4	2
Thienemanniella		1	1
Thienemannimyia grp.		4	2
Tipula		-99	
Zavrelimyia		1	
EPHEMEROPTERA			
Acerpenna		4	3
Caenis latipennis	6	207	25
Isonychia rufa			1
Leptophlebia		2	
Maccaffertium		1	
HEMIPTERA			
Microvelia		1	
ODONATA			
Calopteryx		-99	
Enallagma		3	
Progomphus obscurus	-99		
PLECOPTERA			

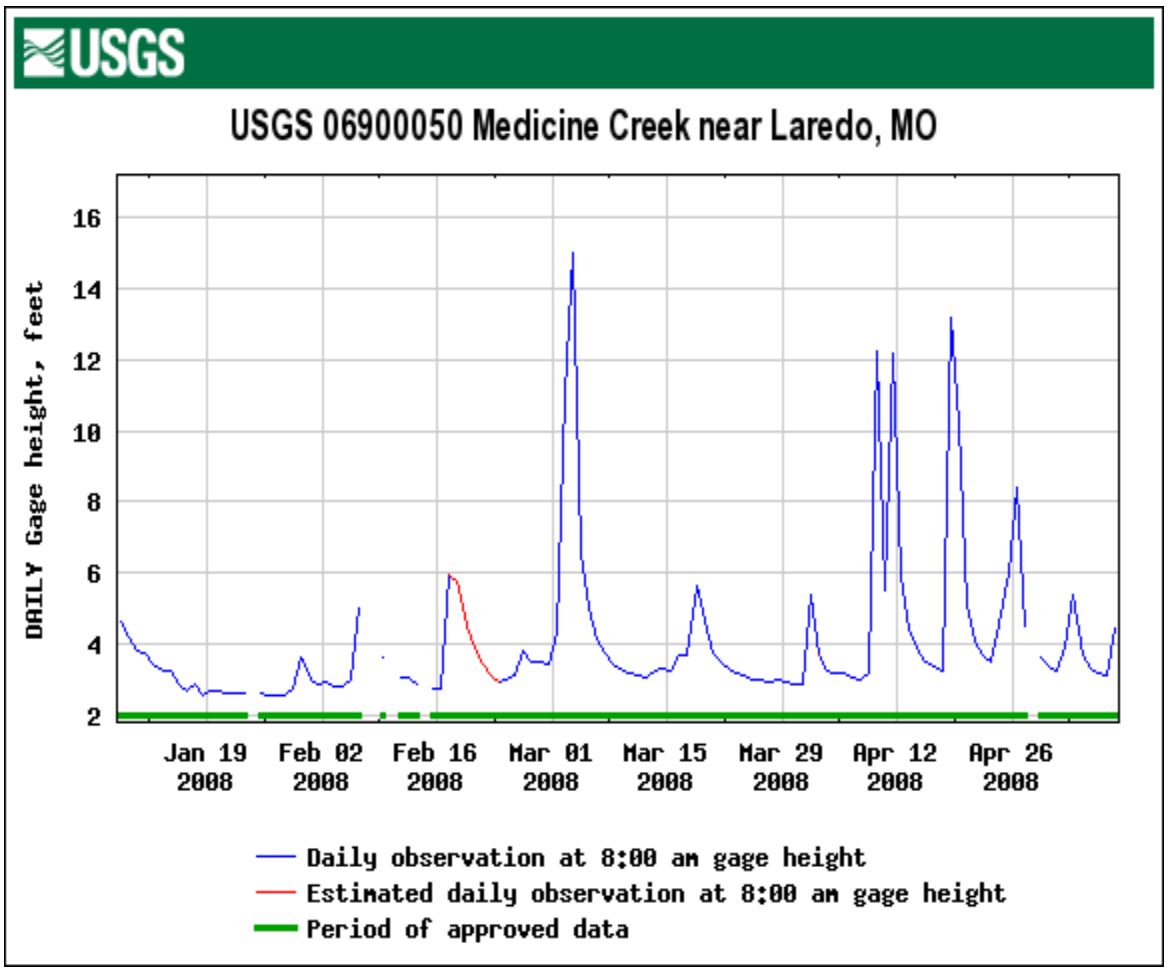
Aquid Invertebrate Database Bench Sheet Report
West Fk Medicine Ck [0804022], Station 2, Sample Date: 3/26/2008 2:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Perlesta		5	
TRICHOPTERA			
Cheumatopsyche		4	1
Ironoquia		5	
Nectopsyche		1	
TUBIFICIDA			
Enchytraeidae	3	7	3
Limnodrilus hoffmeisteri		1	
Tubificidae	3	3	

Appendix C

USGS National Water Information System, Web Interface for Medicine Creek, near Laredo, Missouri
Gage height and discharge information, January 1, 2008–May 1, 2008
Sample Dates March 26 and 27, 2008

GAGE HEIGHT


USGS
USGS 06900050 Medicine Creek near Laredo, MO
DAILY Gage height, feet
16
14
12
10
8
6
4
2
Jan 19 2008
Feb 02 2008
Feb 16 2008
Mar 01 2008
Mar 15 2008
Mar 29 2008
Apr 12 2008
Apr 26 2008
Daily observation at 8:00 am gage height
Estimated daily observation at 8:00 am gage height
Period of approved data

DAILY DISHCARGE